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A scoping study with cookstove programmes in India and Kenya

Fiona Lambe, Marie Jürisoo, Carrie Lee and Oliver Johnson

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Cover Photo: Care's WPower initiative in Kisumu, Kenya, brings women groups together to learn about and purchase ecological products from EcoZoom that will improve their health, income and environment. © EcoZoom

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A promotional photo for Prakti Design cookstoves, which are being sold in India as part of a carbon-financed project.

EXECUTIVE SUMMARY

Efforts to bring cleaner, more efficient stoves to the billions of people who use traditional biomass for cooking and heating have gained new momentum in recent years, driven both by longstanding health and environmental concerns, and by a growing recognition of the importance of modern energy access for development. In this context, carbon finance is emerging as an attractive option to help scale-up cookstove projects, through the Clean Development Mechanism (CDM) and through voluntary markets, where demand for credits from cookstove projects has been rising rapidly. This report uses case studies of India and Kenya to examine the growing role of carbon finance in cookstove projects, with a focus on how it might support market transformation.

Little research has been done on how cookstove projects are using carbon finance. In order to address this gap, we conducted an in-depth review of the project design documents (PDDs) for 75 carbon-financed cookstove projects in India and Kenya. We also interviewed 49 stakeholders along the value chain, including cookstove project implementers (both carbon-financed and not), households, NGOs and cookstove and carbon market experts.

A consensus is emerging among policy-makers and donors that a market-based approach is needed to scale-up cookstove initiatives and ensure their long-term sustainability. The literature on cookstove initiatives and our own prior research suggest that projects face two key challenges: motivating households to adopt and use the new stoves, and securing adequate resources for project implementation, including startup costs, market research, product development, outreach and promotion, finance for users (e.g. microloans), and after-sales support and monitoring. Our analysis focused on how carbon finance might help or hinder projects in meeting those challenges. Although the scope of the study is too narrow to draw generalizable conclusions, and most of the projects reviewed are in the very early stages, we identified several patterns and emerging trends:

- In India, a majority of the 43 carbon-financed cookstove projects – 29 – are individual CDM activities; four are CDM Programmes of Activities (PoAs), each with one component project activity (CPA) so far; and 10 Gold Standard projects. In Kenya, the Gold Standard dominates, with 17 projects; in addition, there are five PoAs, with a combined 15 CPAs; one of the PoAs is also registered as a Verified Carbon Standard project.

- In both India and Kenya, businesses make up the majority of project developers – though many are social entrepreneurs with explicit sustainable development objectives; only 22% of projects in India and 10% in Kenya are being developed by NGOs. Several developers are applying the same business model in multiple locations, through PoAs and as individual projects.

- The affordability of stoves is a major concern for most project developers; 92% of the PDDs reviewed cited household poverty as a barrier to adoption of their stoves, and many developers interviewed also raised the issue. Some projects use microfinance, bulk discounts and other mechanisms to help households buy stoves, but high-end price subsidies are the most common approach. In the PDD review, 73% of projects in India and 39% in Kenya planned to give away stoves, and 24% in India and 35% in Kenya provided partial price subsidies. Nearly all the projects selling stoves at full price are in urban settings, where households usually buy fuel rather than collecting it for free, so they have a financial incentive to buy efficient stoves.

- Many project developers, especially smaller businesses and NGOs, also face financial barriers, including lack of access to credit for working capital, low profit margins, and high upfront capital costs. A majority of the carbon-financed project developers we interviewed were relying solely on carbon revenues to cover project costs. Startup and monitoring costs were being covered by loans backed by the credits expected, but not yet generated, from the projects.

- A number of larger commercial actors, particularly in Kenya, are pursuing carbon revenues but do not consider them necessary to sustain their core business. They argued that either the business was viable before they sought carbon finance, or that they needed the carbon revenue only for the initial phase of their projects. While this raises concerns about the additionality of the emission reductions achieved from cookstove projects, it also suggests a need for "transitional crediting", where carbon finance is used for a limited time period only, until a project is self-sustaining.

- Several project developers (11 of the 17 interviewed) are using carbon revenue to provide after-sales support to households and repair or replace broken stoves. Other reported uses of carbon finance include research and development, engagement with users to ensure the stoves meet their needs, establishment of distribution networks, promotional schemes, and provision of finance to households that buy the stoves.

- Accessing carbon finance requires tracking stove use and ensuring that the predicted emission reductions actually occur. Project developers cited many challenges in accurately estimating fuel use, with traditional and improved stoves alike. In the PDDs reviewed, 85% of projects assumed some continued usage of the old stoves, and provided for usage monitoring of both the old and new stoves; the others required the removal or destruction of the traditional stove to attempt to ensure adoption of the new stove technology.

- Several project developers described the monitoring, reporting and verification (MRV) requirements of carbon finance as beneficial, as they encouraged follow-up with users. The projects use a variety of methods to register and track users; a majority of interviewees use consultants, known as "validators", to visit a sample of households, check if the stove is in use, and ask questions about usage rates. A limited number of the project implementers interviewed, and notably the NGOs, do their own monitoring, hiring local staff in the villages.

Our findings show that carbon finance can be valuable to support further dissemination of improved cookstoves. It can help build an increasingly vital market for improved cookstoves, attract international actors and technologies, help establish standards for monitoring stoves, and facilitate better follow-up and support to end users.

However, our findings also show that pursuing carbon finance for cookstove projects carries risks, not least of which is a potential mismatch between the efficiency needs of a carbon project and the complexities and cultural sensitivities required for a successful improved cookstove intervention. As a consequence, project implementers struggle to make reliable predictions about user uptake, leading to unexpected deviations in credit generation. Some implementers also underestimate the time and effort that is required to generate carbon credits; this has consequences for the timing of delivery of credits. Another, major risk is the uncertainty about future – or even near-term – demand for carbon credits of all kinds. Demand for credits is hinged not only on ambitious climate mitigation targets, but also a willingness from countries and companies to use international credits to meet these goals.

Given the growing interest in carbon-financed cookstove projects, we would recommend building on this study by examining trends in other regions, and following up on India and Kenya as the projects there gain more experience. For the best insights on the effects on market transformation, future studies should also compare carbon-financed projects with a control group not using carbon revenues.

1 INTRODUCTION

The imperative to provide universal access to reliable and clean energy is increasingly well recognized (Banerjee et al. 2013), and has led to international commitments such as the UN's Sustainable Energy for All initiative. While 1.3 billion people lack access to electricity, more than double that number – about 3 billion, mainly in South Asia and sub-Saharan Africa – still rely on solid fuels for cooking and heating (IEA 2012). Traditional biomass fuels such as firewood, charcoal and dung are typically burned in small, simple stoves or open fires that are not only inefficient, but emit a great deal of smoke. The human cost of relying on traditional biomass energy for household cooking is well documented, with newly published data from the World Health Organization showing that 4.3 million people died in 2012 due to cardiovascular and respiratory diseases linked to household air pollution, almost all in low- and middle-income countries (WHO 2014).

For those who have to collect their own firewood, the task can be hazardous and time-consuming, precluding income-earning activities or school attendance. In scaling-up access to modern energy services, the developing world also faces the challenge of coping with global climate change, which is linked with both energy production and use, and deforestation. At the regional and global scale, the burning of biomass in inefficient household stoves releases large amounts of black carbon, contributing to air pollution and short-term global warming.

Large-scale adoption of improved cookstoves that use fuel more efficiently, produce less smoke, or both[1] is crucial to addressing these problems. However, although governments and development agencies have been working to achieve this for decades, progress has been limited. It has become clear that in order to make a substantial and long-term impact, cookstove initiatives need to produce a transformation of local stove markets which is self-sustaining and demand-driven. Still, success stories – such as the Ceramic Jiko stove in Kenya (Winrock International 2011) or the New Lao stove in Cambodia (Simon et al. 2012), both of which transformed markets and achieved large fuelwood and charcoal savings – remain the exceptions, not the rule.

The challenges for cookstove initiatives and enterprises are significant: to generate demand for new products that may be expensive for low-income households,[2] develop functioning supply chains to reach dispersed populations, and overcome social and cultural barriers to household adoption of the new technologies. However, we also know what it takes to ensure the large-scale adoption of improved cookstoves and transform markets, based on past experience. Most notably, the stoves must be affordable but also meet households' needs and be seen as real improvements over traditional stoves. The projects themselves also need to have appropriate financial and human resources, not only to get off the ground, but to sustain operations and provide ongoing support to stove users.

This report examines the potential for carbon finance to support the development and scale-up of cookstove projects that achieve large-scale adoption and market transformation. There is a growing momentum at the international level to scale up access to cleaner cookstoves and fuels, as an energy access issue as well as for public health and environmental benefits. The Global Alliance for Clean Cookstoves (GACC) was launched in 2010 as a public-private partnership to bring household energy back to the policy agenda of international development agencies and to mobilize high-level commitments (including finance) towards the goal of universal adoption of clean fuels and stoves.[3] Scaling up access to improved cookstoves is also a priority for the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC), established in 2012.[4] A number of governments have

1 There is no universally accepted definition of "improved cookstove", and designs and stove performance vary greatly. However, fuel-efficiency and reduced air pollution compared with traditional stoves or three-stone fires are widely regarded as the two key qualities (Akbar et al. 2011). See also http://www.cleancookstoves.org/our-work/the-solutions/cookstove-technology.html. Cookstoves can be rated and compared based on the International Workshop Agreement tiers; see http://www.iso.org/iso/catalogue_detail?csnumber=61975.

2 Many of these new enterprises are disseminating improved cookstoves with proven capabilities in terms of achieving significant gains in terms of efficiency and emissions reductions.

3 See http://www.cleancookstoves.org/the-alliance/.

4 See http://www.unep.org/ccac/. GACC is co-leader, with the government of Nigeria, of the Coalition's initiative to reduce emissions from household cooking and heating.

committed to national household energy programmes as well (e.g. India, Bangladesh), and there are regional initiatives, such as the West Africa Clean Cooking Alliance under the Economic Community of West African States.

At the same time, a new wave of cookstove initiatives is now being implemented by private-sector actors aiming to develop commercial ventures by creating demand for higher-quality, often industrially produced stoves. This is promising because the most successful cookstove programmes to date – the ones that achieved the most widespread and sustained use of the stoves – have been commercial in nature. They have still typically involved some donor investment, particularly in their early phases, and have often involved partnerships between international development agencies and NGOs, national governments, and local entrepreneurs and NGOs (Bailis et al. 2009; Kees and Feldmann 2011).

All these efforts require funding, and many cookstove programme implementers see carbon finance as an attractive revenue option. This type of finance differs from traditional donor support in that the money is only paid when agreed-upon results are delivered and verified – in this case, greenhouse gas emission reductions. In that sense, carbon finance is a form of results-based finance (RBF), an approach that provides payments for delivery of a pre-specified output or outcome. RBF emerged primarily in the health sector and is now increasingly used by international financial institutions and some donors to support low-carbon energy access programmes[5] (ESMAP 2013). RBF and carbon finance share many features and procedures, including monitoring and the possibility of longer-term support. An important difference, however, is that RBF relies on donor finance that is at least partly intended to cover the cost of market development, and hence does not rely (fully) on the market for funding.

The use of carbon finance in cookstove projects is a relatively recent phenomenon and, despite fluctuation in the global market for carbon credits, is gaining traction internationally.[6] Although the core purpose of carbon finance is to reduce GHG emissions, not to transform cookstove markets in developing countries, many programme implementers are tapping into carbon finance to support a commercial scale-up of their efforts (Zerriffi 2011). NGOs are also pursuing carbon finance to fnud the wider dissemination of improved cookstoves. However, little research to date has critically examined the role of carbon finance in overcoming the challenges faced by cookstove interventions and whether the use of carbon finance can support improved-cookstove market development in the longer term. This report intends to begin filling that gap.

5 See, for instance, projects by the UK Department for International Development: https://www.gov.uk/result-based-financing-for-low-carbon-energy-access-rbf, and the World Bank: https://www.wbcarbonfinance.org/Router.cfm?Page=CIDEV&FID=65997&ItemID=65997

6 This is evidenced, for example, by the Clean Cooking Loan Fund launched recently by the Global Alliance for Clean Cookstoves, The Gold Standard Foundation and Nexus Carbon for Development. See http://lcedn.com/blog/2014/02/27/first-of-its-kind-carbon-finance-loan-fund-launched-to-spur-clean-cookstove-and-fuel-market/.

2 APPROACH OF THIS STUDY

This report uses case studies of India and Kenya to examine the potential for carbon finance to help cookstove projects successfully scale-up and begin to transform local markets. It should be noted that most cookstove projects engaging with carbon finance are still in the relatively early stages; for example, only 10 of the 75 cookstove projects we reviewed had already issued credits. Thus, it is difficult to know what impact the carbon revenue will ultimately have. However, by examining how various types of actors are using (or plan to use) carbon finance within their business models, and how this fits with what the literature tells us about the core ingredients for cookstove market transformation, we can provide an early glimpse of how the use of carbon finance may affect market development.

2.1 Research questions

Our research examines the various ways in which carbon finance is being used in cookstove projects in India and Kenya, assessing the degree to which it supports or disrupts the ability of the stove initiative to scale-up and achieve wider market penetration. We examine the following questions:

1. How has carbon finance been used so far by project developers, i.e. what role does it play within the financial and operational structure of the project?

2. What effects has it had on (i) immediate project implementation, and (ii) the longer-term goal of market transformation?

3. What are the risks (and benefits) associated with cookstove interventions drawing on carbon finance?

2.2 Methodology

To answer our research questions, we conducted a scoping study with two components: a desk review of project design documents (PDDs), and field research in Kenya and India. We chose these two countries because both have a long history of cookstove activities (government- and donor-led), and a large opportunity to expand the adoption of improved cookstoves, but they vary in their levels of experience participating in the carbon market. Combined, the general observations generated from the review of PDDs and in-country interviews were used to point to trends in how project implementers are using carbon finance, the possible risks and benefits that might accrue, and key areas for future work.

Case studies in Kenya and India

Our use of two case studies together follows a qualitative research approach outlined by Creswell (2007). Our methodology was designed to gather a wide range of perspectives on the use of carbon finance in cookstove interventions. We conducted a total of 49 interviews (22 in India, 27 in Kenya) with a range of actors in the chain of production and consumption – from end users, to local producers, stove designers, carbon project developers, funders, NGOs involved in stove distribution, cookstove entrepreneurs not currently engaging with carbon finance, and household energy sector experts. Along with the interviews and observations in the field, we conducted a review of all available PDDs for carbon-financed cookstove projects in India and Kenya. The combination of field research and PDD reviews allowed us to examine in greater detail how various cookstove actors are using carbon finance and the impact it has had on their businesses/projects, as well as to check or "ground-truth" some of the key assumptions made in the PDDs.

The analytical framework for both the PDD reviews and the field research is grounded in the literature on cookstove interventions, focusing on known barriers and known factors that contribute to achieving large-scale adoption and market transformation. Section 2.3 below provides an overview of that literature.

It is important to note that there are limitations to working with PDDs. Our research and past experience indicate that the project design given in the PDDs can differ significantly from how projects are actually set up. Our interviews with project developers were used, in part, to verify a number of core elements in the PDDs, including but not limited to stove pricing, use of carbon revenue, financial barrier analysis, distribution model and stove replacement process. We did not, however, systematically replicate the criteria evaluated in the PDD reviews, nor is the sample of interviewees in India and Kenya representative of the PDD data set.

We should also stress that this is not an exhaustive study of carbon finance and cookstove projects worldwide, but a look at the experience to date in two countries, Kenya and India. Therefore, our findings may not be generalizable beyond those two countries; studies in other locations will be needed to provide a

fuller picture. Also, as noted above, given that most of the projects reviewed are in the very early stages, we cannot yet know what the impact of carbon finance will be once the projects are fully implemented. All we can point to are trends in how implementers are engaging with carbon finance, and what the impact of this might be based on the literature on cookstove market development.

2.3 A framework for analysing market transformation

Market transformation in the context of cookstoves entails large-scale change, beyond individual projects, to the point that consumers in the area, and in some cases nationwide, widely embrace new cooking practices and technologies and cleaner fuels (Atteridge et al. 2013). Market transformation also implies a sustainable transition in social and business terms, whereby momentum is generated beyond the scope and one-off financial inputs of any specific intervention. It implies a demand-driven scale-up of improved cookstoves, and sustained use of the new technology.

Studies of past projects have identified several elements needed for innovation and market transformation of the cookstove sector to take place: stove technical factors (improved efficiency and reduced emissions); design factors (including how well the stoves meets the diverse needs of heterogeneous users, and whether users perceive the stoves as a real improvement); quality and durability; accessibility to consumers (including affordability, availability of stoves and fuel in local markets, and ease of installation and use in the home); access to start-up finance for the business/enterprise; and an enabling policy and regulatory environment, including an established system of standards/regulations for cookstoves (Simon et al. 2012; Rehfuess et al. 2013; Cordes 2011). GIZ has found that a fully commercial approach is the most important factor in achieving long-term sustainability in cookstove initiatives (GIZ n.d.).

Many cookstove projects use subsidies to keep prices affordable, either direct (price subsidy) or indirect, covering the costs of research and development, producer training, public awareness-raising, etc. (Rai and McDonald 2009). Notably, cookstove programmes that have been most successful have not applied direct subsidies to the price of the stove, but have instead used indirect subsidies to support R&D, manufacturing, and marketing (Akbar et al. 2011; Cordes 2011). A recent review of the enablers and barriers to the uptake of improved cookstoves found that large subsidies can diminish the perceived value of the stove, and thus reduce households' willingness to use, maintain and eventually repurchase the product (Rehfuess et al. 2013). The same study found that overall, an entrepreneurial mode and appropriate business skills are crucial to the success and financial viability of cookstove initiatives seeking to create demand for their products. Commercial ventures have the direct incentive to improve products on an ongoing basis to meet user needs and expand their customer base.

Based on these insights from the literature, and on the findings of recent SEI studies on household energy transitions, we have focused our analysis of carbon-financed projects in Kenya and India PDDs on their ability to overcome two key barriers:

- **Motivating end users**: There are a number of ways to ensure that the user is motivated to purchase and adopt a cookstove, but a fundamental requirement is that the product be **desirable to the end user** in terms of utility, cultural appropriateness, aesthetics, and perceived improvement over the old stove (Shrimali et al. 2011; Simon et al. 2012; Rehfuess et al. 2013; Cordes 2011; Barnes et al. 1993). This generally requires tailoring the stove design for different target audiences (Simon et al. 2012). Investing upfront in market research and applying a user-centred approach to the design of the stove can help to ensure the development of a final product that users are motivated to purchase and adopt (Lambe and Atteridge 2012). If the stove provides tangible benefits, such as reduced fuel costs, an **incentive** is created for the household to adopt the stove (Brinkmann et al. 2014). Research has also demonstrated the importance of **post-acquisition support**, such as a repairs warranty and follow-up with users (ibid.).

- **Ensuring adequate resources**: Lack of resources, both financial and human capital (e.g. technical expertise), is a frequently cited barrier to the success of cookstove projects. **Access to seed capital** for market research, product design and basic marketing is essential; otherwise, cookstove enterprises may struggle to get off the ground (Shrimali et al. 2011). On the demand side, even if the stove design meets the needs and preferences of the end user, the lowest-income households often have difficulty managing the upfront cost of an improved cookstove (Shrimali et al. 2011). **Innovative financing mechanisms**, such as allowing households to pay in instalments, linking

with village level savings and loans schemes, and working with microfinance institutions to market and distribute stoves, can be one way to overcome this barrier (Brinkmann et al. 2014).

Business models that can meet the above challenges are likeliest to achieve market penetration. Thus, our analysis focuses on how well the cookstove projects' business models address those challenges and apply known good practices such as taking a user-centred approach. We also look at how carbon finance in particular is used to help overcome key barriers – for example, whether carbon revenues are reinvested in product R&D and design improvements, or whether they help ensure the projects' financial sustainability.

2.4 Roadmap of the report

We begin by providing some background information on carbon markets, the improved cookstove sectors in Kenya and India, and the two countries' respective experiences with carbon markets (Section 3). We then present the findings of our PDD review (Section 4) and our analysis of the role of carbon finance in cookstove projects' business models, based on interviews with various market actors (Section 5). Next, we identify key benefits and risks associated with using carbon finance in cookstove projects (Section 6). We end with some thoughts on the suitability of carbon finance for cookstove projects, based on our two case studies, and some recommendations for further research.

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A modified shipping container serves as a store in Laikipia, Kenya, through which Top Third Ventures conducted pilot sales of its Baker Stove in 2013.

3 THE EVOLVING ROLE OF CARBON FINANCE IN COOKSTOVE PROJECTS

This section provides a brief introduction to carbon markets, a few different methodologies for carbon finance, and an overview of carbon markets and improved-cookstove activities in India and Kenya.

3.1 Different types of carbon markets

Carbon credits (offsets) can be used for compliance with emission reduction obligations under cap-and-trade systems, or for voluntary emission reductions. Each offset programme has its own set of approved methodologies for quantifying the volume of emission reductions achieved for each specific project type.

The UN-approved standard for offsets comes from the Clean Development Mechanism (CDM), which was created under the Kyoto Protocol with a dual purpose: to reduce the cost of climate change mitigation by providing flexibility in where GHG emission reductions occur, and to promote sustainable development through the transfer of financial resources and sustainable technologies to developing countries. CDM credits, called Certified Emission Reductions (CERs), can be used to meet obligations under the Kyoto Protocol or under national or regional cap-and-trade systems. The CDM is currently the only programme that can issue carbon credits from developing countries to be used for compliance in developed countries. Primary demand for CERs comes from corporations that have an emission reduction obligation under the EU's Emissions Trading Scheme (EU ETS) and from a handful of European governments.[7]

Voluntary markets serve businesses, organizations and individuals seeking to offset their GHG emissions even though they are not required to. Demand is driven primarily by companies motivated by corporate social responsibility or a desire to show leadership in the industry; in recent years, there has been a growing interest in funding projects that deliver development, environmental and social benefits along with emission reductions (Peters-Stanley and Yin 2013). There are several different voluntary standards for carbon offsets, including the Gold Standard, the American Carbon Registry, and the Verified Carbon Standard.[8] The vast majority of voluntary-market emission reductions are contracted bilaterally, not purchased on exchanges (ibid.).

Demand for credits eligible for compliance with Kyoto targets, as evidenced by the price for CERs, has been on steady decline since 2012. Many reasons can be cited for this, including reduced mitigation commitments, a weak economy in Europe (which reduces activities that produce emissions), and reluctance from countries with commitments under the Kyoto Protocol to use credits from the CDM to meet mitigation targets. Due to concerns about CER quality and oversupply, as well as a desire for large and emerging developing countries to move to sectoral approaches, the EU adopted the so-called "LDC rule" within the EU ETS. As of 1 January 2013, credits from projects registered after 2012 may only be used for compliance if they come from a Least Developed Country (LDC).[9] In other words, for non-LDCs, such as India and Kenya, credits from projects registered in 2013 or later no longer have a market among the entities covered by the EU ETS. Ironically, this geographic restriction does not guarantee greater

7 The governments of Norway and Sweden are actively purchasing CERs for compliance with national targets; see http://www.nefco.org/financing/norcap_call_for_proposals (Norway) and https://www.energimyndigheten.se/en/About-us/Press-/Press-releases/The-Swedish-Energy-Agency-issues-a-Call-for-CDM-Proposals/ (Sweden). Sweden plans to use CERs to meet one-third of its national emission reduction target for sectors not covered by the EU ETS (a 40% reduction by 2020 from to 1990 levels). The UK is purchasing credits through the World Bank's Carbon Initiative for Development (Ci-Dev); see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/260581/cmf_business_case.pdf, The German Development Bank (KfW) is also involved is a few market development initiatives;see https://www.kfw-entwicklungsbank.de/International-financing/KfW-Entwicklungsbank/Environment-and-climate/Klima%C2%ADschutzfonds/PoA-Förderzentrum-Deutschland/.

8 For more information on the Gold Standard, see http://www.goldstandard.org; for the American Carbon Registry, see http://americancarbonregistry.org; for the Verified Carbon Standard, see http://www.v-c-s.org.

9 This restriction applies only to corporations buying for compliance on the EU ETS. EU Member States may still use CERs from non-LDC countries to meet their national targets for sectors not covered by the EU ETS.

(sustainable) development benefits, as many of the world's poorest people live outside LDCs.

The voluntary market is much smaller than compliance markets, with 101 million tonnes of CO_2-equivalent ($MtCO_2e$) traded in 2012, versus a total of 10.7 billion $MtCO_2e$ traded in global carbon markets (Peters-Stanley and Yin 2013; Bloomberg New Energy Finance 2014). However, although voluntary market activity has fluctuated since the 2008 economic crisis, prices have been much more stable than in compliance markets, averaging $6.20 a tonne in 2011 and $5.90 in 2012 (Peters-Stanley and Yin 2013), while EU carbon prices for domestic units (European Emission Allowances, EUAs) have gone up and down, hitting a record low of €2.63 ($3.44) per tonne in April 2013, then rising again to average €6.45 in February 2014.[10] Secondary-market CER prices, meanwhile, have remained extremely low, fluctuating from an average of €0.17 in March 2013, to €0.65 in September 2013, back down to €0.19 in March 2014 (Desai et al. 2014).

The voluntary market has also been particularly favourable to projects involving small-scale, decentralized energy solutions such as improved cookstoves, water purification technologies and solar lights. This is reflected in record-high volumes of contracted carbon credits from cookstove projects in 2012, 5.8 $MtCO_2e$ (Peters-Stanley and Yin 2013, p.22). Projects like these are seen as improving living conditions and generating development co-benefits, a "premium value" that appeals to buyers: voluntary-market demand for cookstove project credits was valued at $65.3 million in 2012, up 54% from 2011 (Peters-Stanley and Yin 2013). The increased demand has also led to an increase in supply: in 2012, cookstove projects accounted for 8% of total trading (ibid.), the fourth-largest project type. They are also projected to be No. 2 for 2013-2020, with $730 million worth of credits in the pipeline (ibid.). This is particularly notable given that cookstoves were not even listed as a project type when the same survey was conducted in 2010 (Hamilton et al. 2010). The increased availability of cookstove credits has led to a price decrease, however, from $13.20 in 2011 to $11.30 in 2012 (Peters-Stanley and Yin 2013).

3.2 Carbon credits from cookstove programmes: an emerging market

Four offset programmes have methodologies to credit cookstove projects: the CDM, the Gold Standard, the American Carbon Registry (ACR), and Verified Carbon Standard (VCS). To date projects have been developed primarily through the CDM and the Gold Standard, with a handful of projects under the VCS. A total of 96 cookstove projects have been registered in the carbon market, 61 under the CDM, 32 under the Gold Standard and three under the VCS (UNEP Risoe Centre 2014; Markit Financial Information Services 2013; APX n.d.).

Under the CDM, cookstove projects can be developed either as individual CDM project activities or as part of a Programme of Activities (PoA). A PoA operates on two levels: the programme level, which provides the organizational structure for implementation, and the component project activities (CPAs).[11] Both single project activities and PoAs must go through the same registration and approval process, but under a PoA, additional activities (CPAs) can be developed and included on an ongoing basis after registration. This aggregation process reduces transaction costs and facilitates scaling-up of project activities. PoAs are considered particularly appropriate for small-scale, decentralized projects.

CDM cookstove projects have been developed using either the AMS II.G or AMS I.E. small-scale methodologies.[12] As shown in Figure 1, project activity peaked in 2012 and dropped in the past year.[13] CPAs developed under PoAs have come to dominate project activity, as shown in Figure 1. Nevertheless, improved cookstove projects only make up 1% of all registered CDM projects, including both single CDM and PoAs

10 Average monthly prices from Desai et al. (2014); for record low see: Garside, B., Allan, A. and Chestney, N. (2013). EU carbon hits new record low after backloading vote. Reuters, 16 April. Update 1. http://www.reuters.com/article/2013/04/16/eu-ets-vote-idUSL5N0D31ZM20130416.

11 CDM Rulebook, "What is a Programme of Activities?" http://cdmrulebook.org/452. [Accessed 19 March 2014]

12 AMS II.G, "Energy efficiency measures in thermal applications of non-renewable biomass", http://cdm.unfccc.int/methodologies/DB/UFM2QB70KFMWLVO7LJN8XD1O2RKHEK. AMS I.E., "Switch from non-renewable biomass for thermal applications by the user", http://cdm.unfccc.int/methodologies/DB/WHTQUFLWCVNB9CIUZC198A712WGQR4.

13 Our interviews indicate that, as might be predicted, many project developers rushed to register their projects before the LDC rule went into effect.

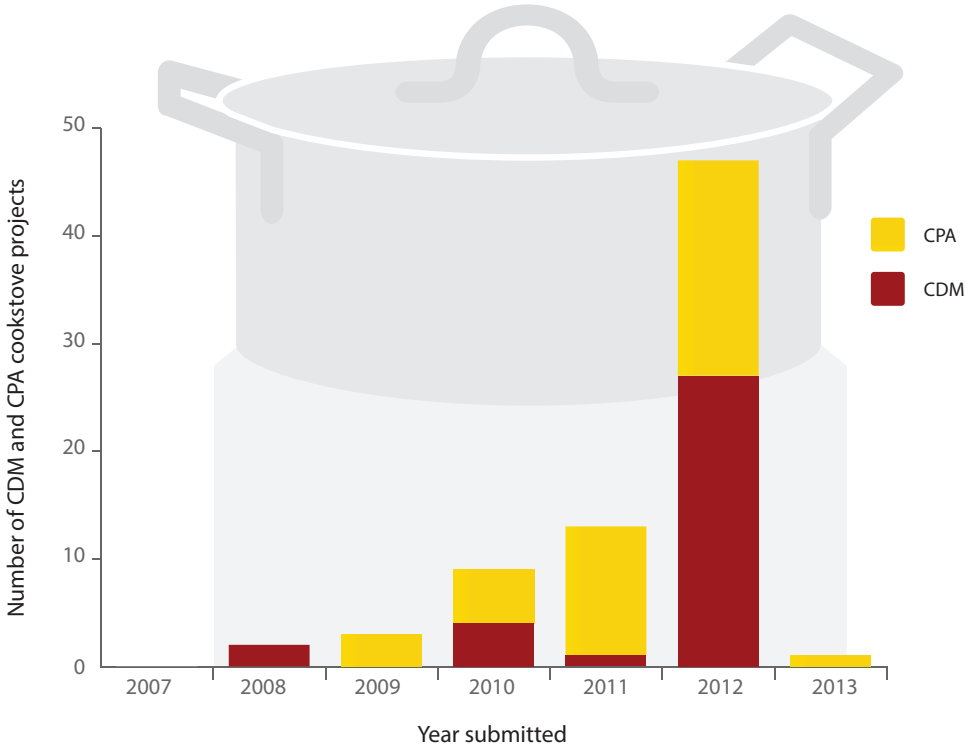

Figure 1: Registered cookstove projects under the CDM by year of project submission 2006–2014, based on date listed for the start of the public comment period.

The VCS project registered in Kenya is also registered as a PoA under the CDM. To avoid duplication, we only count it once.
Source: UNEP Risoe Centre (2014).

(UNEP Risoe Centre 2014). Single CDM cookstove projects are mostly located in the Asia and Pacific regions, while CPAs projects developed under PoAs are predominantly located in Africa, as shown in Figure 2.

Nearly all voluntary projects have been developed through the Gold Standard, either applying a CDM methodology or one of the Gold Standard's own methodologies. Two methodologies are applicable for new projects: "Technologies and Practices to Displace Decentralized Thermal Energy Consumption" (April 2011) and "Simplified Methodology for Efficient Cookstoves" (February 2013, applicable to micro-scale projects). Earlier projects have been developed under the "Indicative Programme, Baseline, and Monitoring Methodology for Improved Cook-Stoves and Kitchen Regimes" (V.01 or V.02), which is no longer valid for new projects.[14] Gold Standard projects are nearly evenly divided across regions, including Latin America, a region where CDM cookstove activity is limited to a few CPAs (see Figure 2). Three projects are registered under the VCS, using the CDM applicable methodologies, two in Africa and one in Asia; one of the Africa projects is also registered as a PoA under the CDM.

3.3 Carbon market experience in Kenya and India

India has a very different carbon market experience than Kenya, or Africa as a whole. India was one of the pioneers in hosting CDM projects and is second only to China in total number of projects, but the carbon market has only recently begun penetrating Africa. For comparison, India has 1,497 registered CDM projects and PoAs; Africa has 252, and Kenya, 30 (UNEP Risoe Centre 2014). Given this difference in CDM experience, both in number of hosted projects and in number of project developers, it is difficult to make meaningful comparisons between India and Kenya.India is host to nearly 20% of the world's CDM projects (UNEP Risoe

14 All these methodologies are available at http://www.goldstandard.org/energy/methodologies.

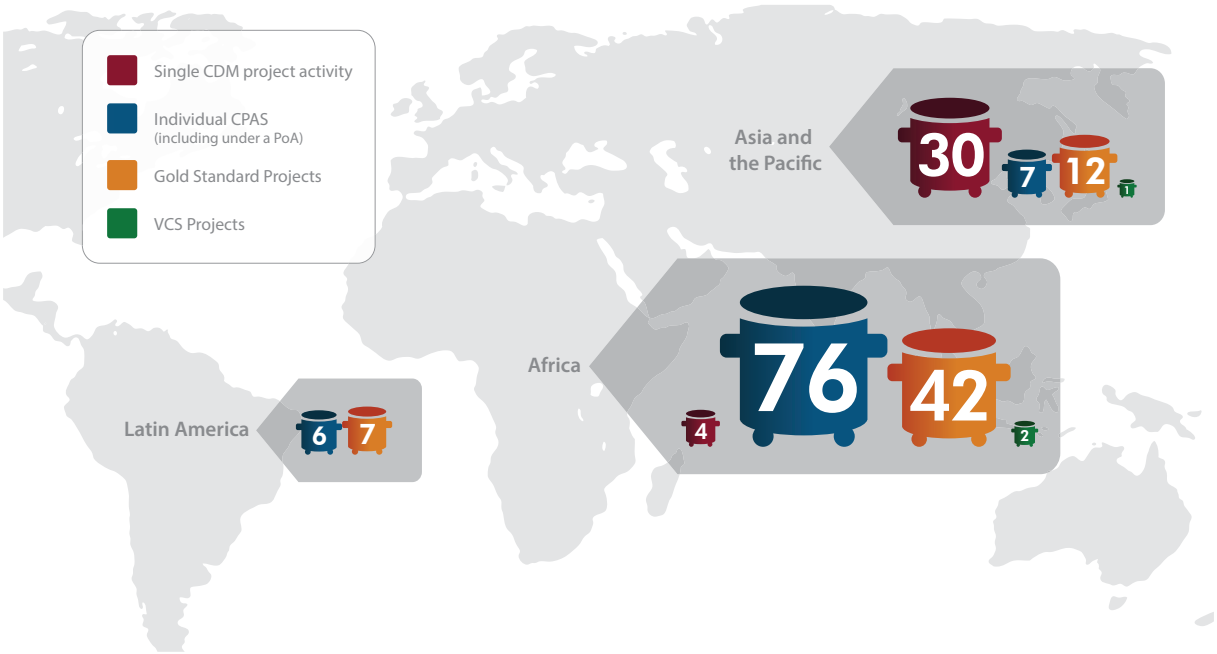

Figure 2: Number of registered cookstove projects by region and offset mechanism.

Source: UNEP Risoe Centre (2014); Markit Financial Information Services (2013); APX (n.d.).

Centre 2014), almost all of them stand-alone activities; as of February 2014, there were only 26 registered PoAs there. India also has a very robust domestic skills base and knowledge about carbon markets. This includes a well-developed national authority for approving CDM projects in the country (the Designated National Authority, or DNA) and a well-trained cadre of "carbon consultants" who develop and monitor carbon projects and keep up with changes in CDM rules. One advantage of having such an elaborate infrastructure in place is that it enables more rapid scale-up of carbon market activities.

Africa's share of CDM projects is still low when compared with other regions in the world, and that is especially true for LDCs. As noted above, as of February 2014, there were 252 registered CDM projects and PoAs (16 registered PoAs and 76 individual CPAs (included under the PoAs), just over 3% of the 7,669 registered projects globally. Only 34 of the 252 had issued credits.[15] PoAs play a significant role in Africa, making up 29% of registered CDM activities. This reflects a common view that also came across in many of our interviews in Kenya, that the African market is well suited for small-scale household energy projects. A majority of the Africa projects reviewed in this study were PoAs or were developed for the voluntary market (often with Gold Standard).

A recent study of CDM uptake in Africa found limited potential (Kreibich et al. 2013), primarily because Africa was late to enter the market, and CER prices crashed "when projects were starting to run and capacities had been finally developed". Some interviewees in our study made the same point; they also noted that for Kenya, the LDC rule has been detrimental to the development of CDM projects, in particular to the development of a local skills base in private-sector consulting and research. Many interviewees also cited the EU policy change as the primary reason for a surge in voluntary-market cookstove projects in recent years.

3.4 Improved cookstoves in India and Kenya

With more than 30 years' experience with cookstove activities, and one of the largest improved wood-stove programmes in Africa, Kenya is at the forefront of cookstove development, marketing and distribution in the region (Winrock International 2011). However,

15 In terms of getting a sense of secured demand for issued credits, it is worth noting that investors and buyers do not have to be listed in the publicly available project design documents, and of the PDDs for Africa projects available on the UNFCCC website, roughly half lacked information about a credit buyer. Globally, 35% of projects listed in the UNEP Risoe database do not show a credit buyer (UNEP Risoe Centre 2014).

most Kenyans still do not have access to improved stoves (Republic of Kenya 2011). As in many developing countries, coordination amongst government agencies in Kenya working on cookstoves has been limited. Until recently, the main actors involved in the development and dissemination of stoves were international development agencies – most notably GIZ, Practical Action and the Global Village Energy Partnership (GVEP) – and local NGOs, which supported local artisans to develop and disseminate improved cookstoves. The Kenyan Ceramic Jiko was designed in the mid-1980s through a collaboration between donors and local artisans. In the 1990s, efforts to promote wood fuel stoves accelerated, driven largely by GIZ, partnering with the Ministry of Agriculture, and Practical Action, in conjunction with Ministry of Energy. In 2005, GIZ launched the Energising Development programme, a global multi-donor program which carries out activities in more than 20 countries with the aim of increasing access to modern energy for households, social institutions and small and medium-sized enterprises. By end of 2012, some 1.4 million stoves had been commercially disseminated around Kenya, serving 7 million people (GIZ 2012).

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A woman in Gokak,Karnataka state, in southwest India, cooks with an improved cookstove

In the late 2000s, cookstove programme implementers in Kenya began to pursue carbon revenues – first focusing on wood stoves, then also on charcoal stoves. Through carbon-financed projects, mass-manufactured and imported stoves are becoming more visible. The ability to earn carbon revenues also attracted a number of large international actors, increasing the financial capacity of the sector (Winrock International 2011).

India, for its part, has a long history of supporting large-scale cookstove programmes, with several initiatives over the past three decades, some led by the government, others driven by local or international NGOs. The results have been mixed. More than 34 million stoves were disseminated to Indian households under the government's National Programme on Improved Cookstoves (NPIC), which ran from 1984 to 2002.[16] However, subsequent impact assessments suggest that the real benefits of the programme in terms of fuelwood and monetary savings at the household level were likely far lower than was claimed in annual reports (Kishore and Ramana 2002). One major shortcoming of the NPIC that has been cited is its top-down approach (Greenglass and Smith 2006). The central government subsidy went directly to stove producers, yet it is apparent that many producers did not consider consumer preferences when designing and marketing stoves, and many households discarded the

16 For a fuller discussion of shortcomings in the NPIC and the current NBCI, see Lambe and Atteridge (2012), pp.7–8.

Table 1: Carbon-financed cookstove projects in India and Kenya

Country	UNFCCC Kyoto Protocol compliance mechanisms		Voluntary standards		Total projects
	CDM	PoA (CPA)	Gold Standard	VCS	
India	29	4 (4)	10	0	43
Kenya	0	5 (15)	17	1	32*
Total	**29**	**9 (19)**	**27**	**1**	**75**

Note: figures include registered CDM projects, registered and at-validation PoA projects, and registered, listed and at-validation Gold Standard projects. CDM indicates individual projects, PoAs are Programmes of Activities, with component project activities (CPAs) listed in parentheses. VCS is the Verified Carbon Standard.

* The VCS project registered in Kenya is also registered as a PoA under the CDM. To avoid duplication, we only count it once.

new stoves within months (Hanbar and Karve 2002; Kishore and Ramana 2002). The subsidy may also have stifled efforts in the private sector to innovate and produce better stove models (Greenglass and Smith 2006). An unfortunate legacy of the NPIC is that many Indian households continue to associate improved cookstove initiatives with this first national programme, and the various associated problems. Overcoming these negative perceptions is one of many challenges facing cookstove entrepreneurs today in India.

In late 2009, the Ministry of New and Renewable Energy launched the National Biomass Cookstoves Initiative (NBCI), with the aim of bringing improved stoves to all Indian households that rely on traditional biomass for cooking. The programme involves the development of "the next generation of household cookstoves, biomass processing technologies and deployment models", and it aims to achieve a level of energy services "comparable to that from other clean energy sources such as LPG" (Venkataraman et al. 2010).[17] Under the programme, subsidies of up to 50% are made available to implementers, provided the stove meets efficiency and emission reduction standards. Currently, only those technical criteria are being considered in the selection of stoves for support under the NBCI; there does not appear to be any equivalent protocol for evaluating how appropriate the technology is in terms of other user preferences. In 2012, with support from GIZ,[18] the Indian Government registered a PoA for cookstove projects; the plan is to leverage the carbon revenues to support the subsidy programme under the NBCI.

A total of 43 carbon-financed cookstove projects have been developed and registered in India, and 32 in Kenya (see Table 1). Over 60% have been developed under the CDM, either as individual CDM projects or as CPAs under PoAs. The Kenya projects are roughly evenly split between the Gold Standard and the CDM, and all of the CDM projects have been developed as CPAs, an indication of the growing role of PoAs. Several of the PoAs in Kenya include coverage for several countries in sub-Saharan Africa. In India, a majority of the projects have been developed as individual CDM projects.

17 As the name of the programme suggests, it distributes only biomass stoves. However, cooking with LPG and other gaseous fuels has a strong aspirational value attached to it, and many end users strive to afford an LPG stove. Many producers of improved biomass cookstoves thus see the availability of LPG as a threat to their business model, an insight that also came across in some of our interviews in India.

18 For more on GIZ support to India in the cookstove sector, see http://www.igen-re.in/files/flyer_-_improved_cookstoves.pdf.

4 HOW DOES CARBON FINANCE AFFECT COOKSTOVE PROJECT DESIGN?

In this section we present the findings of our review of project design documents (PDDs). The analysis includes only *registered* projects: 43 in India, and 32 in Kenya. We gathered information on project characteristics, including developer type (NGO or business and international or national) and market context (urban or rural). We examined how projects proposed to use carbon finance, including stove pricing, use of offset credit revenue, distribution model, and accounting for end-user adoption rates. We also looked at whether a barriers analysis had been conducted, and if so, what it found. For consistency, we based our review solely on the PDDs, without consulting any additional resources or judging whether the assumptions were reasonable or the projects feasible. It is thus important to note that PDDs are written for the purpose of review and approval in the CDM process. While they include information on how carbon finance will be used, they are not written explicitly for the purpose of describing business models. Our field research and past experience with CDM projects also indicate that projects may not be implemented as described in the PDDs, an important limitation of this analysis. It should also be highlighted that in India, one implementer has registered 25 separate but nearly identical CDM projects, which vary only in location, all with the same business model (100% subsidy on the stoves, distributed to households for free). These projects affect the aggregate figures for India, which could be misleading in that it gives the impression that this approach is taken by many different actors.

In the sections that follow, we describe our findings, which are summarized in Table 3 at the end of this chapter.

4.1 Different types of project developers

In both India and Kenya, businesses make up the majority of project developers – though many are social entrepreneurs with explicit sustainable development objectives; only 22% of projects in India and 10% in Kenya are developed by NGOs. While three quarters of the projects in India are developed by Indian organizations, in Kenya nearly all projects are developed by an international organization or a partnership of an international and a Kenyan organization. In several cases, the Kenyan organizations are subsidiaries of the international organizations developing the project. The project design documents for different projects by the same project developer were often nearly identical, with the exception of the project location and size. This was certainly true for CPAs, which are intended to follow a uniform PoA project design, but it also true for individual CDM projects and Gold Standard projects. In India, a network of NGOs has been formed to facilitate development of CDM projects that benefit the poor, and the PDDs from network members shared identical texts for different design elements. This suggests project developers are coming up with a business model and replicating it in several locations, and are most likely selecting project locations that fit their business model, as opposed to adapting the business model to different project conditions.

All the projects in India target rural households that cook with wood; in Kenya 55% target rural households cooking with wood, but there are many projects focused on urban households that cook with charcoal. With few exceptions, the PDDs assume that households using fuelwood gather it for free, while charcoal users are purchasing their fuel.

4.2 Achieving and documenting emission reductions

Improved cookstove projects are unique among carbon market projects in that they depend on end users to achieve emission reductions: households must actually use the improved cookstoves instead of their traditional stoves. This has been a significant challenge. Carbon finance monitoring requirements include checking the efficiency of the stove and confirming at least every two years that the stove is still in use. Additional stove monitoring of the efficiency and usage rate is required annually or biannually. Monitoring requirements furthermore include sampling and surveying users, as specified in the applicable offset protocol.

Carbon finance project monitoring requirements further specify that projects must either ensure that the improved stoves completely replace traditional stoves, or else the traditional stoves must be monitored and accounted for under the project emission reduction calculations. Close to 85% of the PDDs planned to monitor traditional stove usage. In Kenya, the predominant mode of traditional cooking is with a three-stone fire, which many PDDs acknowledge

Table 2: Project developer type and market context of cookstove projects reviewed in India and Kenya

		Country	
		India	Kenya
Project developer type	NGO	17%	10%
	Private	78%	90%
	Both	5%	0%
	National	78%	3%
	International	15%	42%
	Both	7%	48%
Market context	Rural	100%	55%
	Urban	0%	39%
	Total	**60%**	**44%**

cannot be removed or destroyed like a stove might be. One project contemplated using a "rewards club" model, with all households confirmed to not be using three-stone fires entered into a raffle with prizes. In India, the traditional stoves in many project locations are known as chulhas. They are built of mud/clay/cement, without a chimney or grate, and often have religious significance. While few projects in Kenya required the destruction of existing cookstoves, many in India did. One project required that at the time of sale of the improved cookstove, photographic evidence be collected of the breaking of the household's chulha.[19]

4.3 Barriers analysis

In order to qualify for carbon credits, projects have to demonstrate additionality – that the emission reductions achieved through the carbon-financed activity would not have occurred otherwise. One way to do so is to show that there are barriers to the adoption of a low-emission technology – investment barriers, technological barriers (e.g. lack of infrastructure or trained personnel), prevailing practices, etc. – that the carbon finance will help overcome. CDM guidelines do not require a barriers analysis for small-scale projects that target households and communities, or for micro-scale projects. Under the Gold Standard, projects may follow the CDM guidelines for small-scale projects, provide a barriers analysis, or demonstrate that the technology is "first of its kind" in the target area. All but five of the 75 PDDs we reviewed included some analysis of barriers; among them, the most-cited barrier (in 92%) was household poverty, which makes improved stoves unaffordable. For example, a PoA project in Kenya used national-level data on household income, including the percentage of rural households below the poverty line, as the basis to conclude that "the commercial viability of selling stoves to the rural poor is minimal". In another example, an NGO surveyed local communities with regard to fuel use, occupation and family income prior to project implementation and found that targeted households were below the poverty line, with a per capita income of less than $1/day. A project in India worked in partnership with the provincial government and targeted households that are registered as either members of a tribal household or families living below poverty line. Several PDDs for projects in Kenya include simple calculations to assess the ability of households to purchase an efficient cookstove based on their income and their costs for food and fuel; the calculations suggest that households would need to save 22–30% of their remaining income for a year to purchase a stove.

Overall a third of projects (52% in Kenya and 20% in India) cited the lack of access to credit for working capital as a barrier. Close to a quarter of projects – and two-thirds each of projects developed by international entities and in urban contexts – cited low profit margins as a discouragement to private investment and interest in the improved cookstove market. Several

19 The mud chulha is typically made by the households themselves from locally available materials, and often households own several (Lambe and Atteridge 2012), making it difficult to guarantee that a new chulha won't be made following the destruction of the old one.

projects mentioned the barrier of high upfront capital costs for a business that is not "booming". One PDD explicitly states that the long-term goal is to assist in creating a fully commercialized stove industry that is independent of external financial assistance. The PDD makes the case that carbon finance is key to laying the groundwork while return on investment for investors is still low. Similarly, a quarter of projects – including 75% of those with international developers and 67% of those in urban settings – cited a lack of sufficient consumer outreach and/or support for programme operations as barriers. Only 8% of projects cited lack of innovation and limited research and development on stove design as a barrier. Some projects cited the failure of past efforts, where improved cookstoves had not lived up to expectations due to poor design and manufacture quality; this poor past performance has made it harder for newer generations of improved stoves to gain market traction. Another project highlighted the importance of research and development funds to continually improve upon and modify stove designs to suit user needs, which requires ongoing investment that has not always been available for past donor-funded cookstove efforts.

4.4 Stove pricing and subsidies

There are clear patterns in the business models described in the PDDs. The great majority of projects are providing improved cookstoves to households for free (73% in India and 39% in Kenya) or at a subsidized price (24% in India and 35% in Kenya). This pattern is not surprising given the high proportion of projects that cite household poverty as a key barrier, but it goes against strong evidence that stove giveaways and high direct subsidies undermine market transformation (see Section 2.3). Only 13% of projects are selling stoves to households at the retail price – all with microfinance options provided, either by the project developer or through affiliated entities. In the projects with partial price subsidies, the discounts range from 21% to 89% of the retail price, with a median subsidy of 80%. These subsidies only factor in the retail cost of the stove and not the added costs of shipping, importing or distributing the stoves. For example, a PoA in Kenya expects to subsidize the retail cost of $30 by 85%, but when $15–20 USD in operations costs are added on, the subsidy is really closer to 95%. Where retail prices for stoves are given in PDDs, they range from $6 to $30 USD or more; the subsidized prices are set at $3 to $6 USD. One project in Kenya plans to sell a stove with a retail price of $19.50 USD at the subsidized price of $9.50 USD, and provide microcredit options to facilitate the purchase.

Stove pricing varied by region, market context, and project developer type. None of the projects in urban settings distributed stoves for free, while only one project in a rural setting plans to sell stoves at the retail price. In an urban setting, many PDDs note that since households are already purchasing charcoal, they have an incentive to buy an improved cookstove to reduce their fuel costs. Nearly all projects in India that are being developed by nationally based organizations, both private and NGOs, give out stoves for free. In Kenya, there was more of an even split between distributing stoves for free vs. for a subsidized price.

Nearly all (90%) projects said they would use offset sale revenues to subsidize the price of improved cookstoves. A majority (86%) also cited using offset sale revenues to cover operational costs, including maintenance and replacement of stoves, training of cookstove users, outreach and marketing to households, microcredit systems and distribution. Some projects planned to use carbon revenues for market development or to refine the stove designs based on user feedback. The potential impact of these choices for the long-term sustainability of cookstove initiatives will be discussed further in Section 5.3.

4.5 Distribution networks

Nearly three quarters of projects reviewed rely on existing networks and on contacts that project partners have with local communities. This was especially the case for projects in India developed by national organizations, where 83% of projects relied on existing networks, while in Kenya, projects are more evenly split between direct marketing to households and using existing networks. For example, several Indian NGOs developing projects have longstanding relationships with specific communities, and improved cookstoves are one of many development-related efforts they are implementing. Several projects plan to identify and target households based on their registration with the Rural Development and Water Conservation Department as a household living below the poverty line. One project in India, under the Gold Standard, is being developed directly by a local community organization, a 38,000-member labourer village development group. In Kenya, some projects plan to target households through contacts already made with local health workers or participation in national campaigns (e.g. the Integrated Prevention Campaign). In many cases where direct marketing is used to sell stoves, a commission system for salespeople is proposed.

Table 3 summarizes the findings of our PDD review.

Table 3: Summary data from review of project design documents (PDDs).

Project	Characteristics	Country		Project developer type						Market context		Total
Approaches		**India**	**Kenya**	**NGO**	**private**	**NGO-private**	**natl.**	**intl.**	**natl.-intl.**	**rural**	**urban**	
Stove pricing	free	73%	39%	40%	64%	0%	91%	25%	44%	71%	0%	60%
	subsidized	24%	35%	60%	21%	100%	9%	30%	56%	27%	33%	29%
	retail	2%	26%	0%	15%	0%	0%	45%	0%	2%	67%	13%
Use of CER revenue	price subsidy	93%	87%	70%	92%	100%	94%	75%	94%	86%	100%	90%
	operations	90%	81%	60%	90%	50%	94%	80%	72%	81%	100%	86%
	market growth	2%	3%	0%	3%	0%	0%	5%	0%	3%	0%	3%
	R&D	2%	5%	0%	3%	50%	3%	0%	6%	3%	0%	4%
Barriers analysis	not affordable	90%	90%	80%	92%	100%	88%	95%	89%	90%	100%	92%
	lack of credit	20%	52%	60%	31%	0%	9%	35%	67%	36%	33%	35%
	user needs not accounted for	15%	13%	10%	15%	0%	3%	25%	17%	10%	33%	14%
	low return on investment	17%	29%	10%	25%	0%	6%	65%	0%	14%	67%	22%
	lack of consumer outreach/ programme operations	17%	32%	20%	25%	50%	3%	75%	11%	17%	67%	25%
	limited R&D in stove design	15%	0%	10%	8%	0%	3%	25%	0%	10%	0%	8%
Distribution model	existing network	83%	55%	80%	67%	100%	94%	55%	44%	71%	67%	71%
	direct marketing	17%	45%	20%	33%	0%	6%	45%	56%	29%	33%	31%
Handling of traditional stoves	destroy	15%	0%	50%	0%	50%	13%	0%	6%	10%	0%	8.3%
	monitor	73%	97%	50%	87%	50%	91%	75%	83%	81%	67%	84.7%
	either	12%	3%	0%	10%	0%	0%	25%	6%	10%	0%	8.3%
Country	India			17%	78%	5%	76%	15%	7%	100%	0%	60%
	Kenya			10%	90%	0%	3%	42%	48%	55%	39%	44%

Values reflect the percentage of projects that included both the specific project approach in the design (indicated by rows) and the specific project characteristic (indicated by columns).

5 WHAT ROLE DOES CARBON FINANCE PLAY IN PROJECT IMPLEMENTATION?

This section presents the results of our field research in India and Kenya. As noted earlier, although in some cases we interviewed cookstove actors about projects included in our desk review of PDDs, there is no direct correspondence between the interviewees and the projects reviewed in Section 4. Instead, the interviews focused on how carbon finance might help or hinder the achievement of the key criteria underpinning market transformation discussed in Section 2.

We interviewed a total of 17 actors involved in accessing carbon revenues to support the implementation of cookstove initiatives: five from NGOs, two from social enterprises, one from a trade union, and nine from stove businesses (three large, two medium and four small), as shown in Table 4. We also interviewed seven carbon consultants, five household energy sector experts, 12 households and five stove programme implementers who are not currently pursuing carbon revenues. Three of the larger stove businesses are Kenyan; one is international but with operations in India and Kenya. Three of the small businesses interviewed are Indian; one is Kenyan. Two of the NGOs are Indian; three are Kenyan. A list of interviewees is provided in Annex 1.

Project developers reported different motivations, depending on the type of organization. The private-sector actors were all driven to some degree by the need to make a return on investments in the business. All of the large and one of the mid-size businesses said they were depending on a significant scale-up of stove sales to provide returns to their investors, or to repay loans. The core business model for these actors entailed heavy investment in stove design and development, often financed by private actors. Only one of these enterprises is applying price subsidies, although another reported using subsidies for a time in order to kick-start stove sales. The small businesses, although also interested in making a profit, did not have the backing of large investors, and given the scale of the businesses, did not have large loans to worry about. They reported that they aimed to steadily increase stove sales to cover their operating costs while gradually growing the businesses. All the small businesses reported needing price subsidies to enable their customers to afford the stoves.[20] The two social enterprises interviewed are interested in making profits, but reported that their main reason for getting involved in the cookstove sector is to improve livelihoods while having a positive impact on the environment. Both reported selling stoves without any direct subsidy, and both work closely with microfinance institutions to reach their customers. The NGOs we interviewed were generally focused on sustainable development goals, primarily improving household health and livelihoods for women while reducing pressure on the local environment through the dissemination of improved cookstoves. In all cases, the NGOs interviewed were subsidizing stoves at 80–100%.

5.1 How carbon revenues are being used

The main uses for carbon finance reported by interviewees were i) to provide a price subsidy to the end user; ii) to enable greater focus on research and development, operations, and after-sales maintenance, and iii) to support a promotion scheme. Some projects' business models are completely dependent on carbon finance, while others use carbon finance as an additional funding stream. The NGOs that we interviewed fit into the former category, depending on carbon revenues to sustain all project activities, from development/procurement of the stoves to stove dissemination, outreach and monitoring. Two of the five were receiving advance payments from the carbon consultants handling the registration of their projects for carbon credits yet to be generated. Overall, the most widely cited use for carbon finance was for after-sales support and maintenance (11 of the 17), followed by direct price subsidies (9 of the 17). Below we discuss our findings in more detail; Table 4 then provides a summary.

Use 1 – direct subsidy: Four of the businesses (three small and one medium) and all the NGOs interviewed planned to use carbon revenues for direct price subsidies: of 66–80% for the businesses, and 80–100% for the NGOs. All said the subsidies were needed because households could not afford the full cost of

20 This is partly due to economies of scale; the smaller companies have much higher costs to cover per unit, pushing up the retail price of their stoves compared with the larger firms, many of which are able to save on production costs by, for example, shifting manufacturing to China.

the stoves. The fact that smaller, local businesses were likelier to use carbon finance for direct price subsidies than the larger players may be explained by the larger players' access to other sources of finance (either angel investors, large CSR investments, private loans) to cover developing rural distribution networks (including linking with microfinance institutions) and some degree of product marketing. Several respondents, particularly in Kenya, noted that smaller players do not have the resources to set up rural distribution networks and involve microfinance institutions to facilitate "last-mile delivery" of their product, and therefore need to provide high-end user subsidies. Many of the large and mid-sized actors, meanwhile, said that since they had made a considerable investment in "getting the product right" from the beginning, there was less need for subsidies to sell the stoves – their customers were willing to purchase them at full cost, though often with support from innovative finance mechanisms such as micro-loans.

Use 2 – indirect subsidy (enabling greater R&D, operations and maintenance efforts): Five private-sector actors, two NGOs and two social enterprises interviewed reported using some portion of carbon revenues for stove maintenance and/or repair. One of the larger manufacturers explained that their stove was designed to last for a number of years before a key part wore out – but at that point, it would cost as much to replace the stove as to replace the core element, so there was no provision for repairs. All of the large and mid-size businesses had allocated carbon revenues to finance further R&D, to develop new stove models for different market segments, enter new markets, or hone the design of a current model to better fit their customers' needs. One of the social enterprises interviewed reported using carbon revenues to cover the cost of distribution and delivery of cookstoves. All of these larger businesses had developed initial stove designs outside of Kenya/India, typically in U.S. labs, where they ensured they met basic technical parameters, and then they had tailored the technologies to fit local needs through very extensive on-site user testing and several design iterations.

Use 3 – promotion scheme: One small local business in India was using a price subsidy as a temporary promotional measure to get households to try the stoves. As households become used to the new product and recognize its value, the subsidy will gradually be removed. The trade union interviewed also reported planning to pay a portion of the carbon revenues directly to stove users (union members) who will be purchasing the stoves at full cost, though paying in

Table 4: Use of carbon revenues by cookstove producer/distributor type

Type of entity	Additional finance streams	Use of innovative end-user finance mechanisms	User-focused approach to stove design	Direct price subsidy	R&D	Stove maintenance/ repairs
Large manufacturer/ distributor (3)	3	3	3		3	2
Medium manufacturer/ distributor (2)	2	2	2	1	2	1
Small local business (4)	1			3		2
NGO (5)			1	5		3
Social enterprise (2)	2	2	1		1	2
Trade union (1)	1	1	1			1

instalments. In this case, direct payment to end users was seen as a matter of equity in terms of sharing revenue with union members.

5.2 Motivating the end user

As discussed in Section 2, one of the key challenges for cookstove projects is to motivate households to buy and use the stoves. This section examines how different project developers engaging with carbon finance motivate end users, and the role that carbon revenues may play in incentivizing stove use. Specifically, we look at the extent to which a user-focused approach is being taken to stove design, and at how carbon revenues may assist in the provision of after-sales support and maintenance.

Ensuring that the technology meets the needs of the end user

Carbon credits will be generated only to the extent households *use* their new stoves, and thus achieve the expected emission reductions. Ensuring that households adopt improved cookstoves is notoriously difficult because of a range of context-specific social and cultural factors, including cooking methods, taste preferences, local beliefs, etc., which influence perceptions of what makes a good stove and whether an improved stove is desirable. Experience shows that designing a stove which people are willing to use can take time, and involves several design iterations, whereby stove prototypes are field tested, user feedback is gathered and incorporated into the design, and the refined prototype is again field-tested (see, e.g., Lambe and Atteridge 2012). All of the large- and medium-scale actors interviewed had gone to significant lengths to ensure that their stove design meets end users' needs. Some of these entities originated in the U.S, but then transferred operations to Kenya, and for most of them the design process involved the following key steps:

1. Market assessment (anything from a desk review to local data-gathering);

2. Research and development and lab development of initial prototype;

3. Prototyping (testing stove with users);

4. Feedback from user testing phase to lab for design modification; and

5. Mass manufacture.

One large actor had bought the rights to a cookstove developed by a well-known Swedish design bureau that had applied a highly user-focused approach to the design, with several rounds of user testing and iterative loops. All but one of the large and medium-sized actors are selling stoves in significant volume, and only one was relying on a price subsidy to sell the product (not funded by carbon revenue). Asked why their stoves were selling relatively well without subsidies, respondents repeatedly cited the stove design – that they had developed a product that made sense to their customer base, and had hit upon a key "value proposition" for the end user.

It is important to stress that most of these actors had developed and thoroughly tested their product *prior* to seeking carbon revenues, and they had the resources to do so. One of the most successful cookstove entrepreneurs (in terms of volume of stoves sold without subsidies), a medium-sized Indian company, had conducted extensive user testing of its stove in multiple states in India to gather user insights which fed back into the design of the stove. The medium- and large-scale companies we spoke with were generally of the opinion that carbon finance makes sense as a relatively low-risk additional finance stream precisely *because* they are so sure of their product.

Beyond conducting a basic cookstove pilot test, the small businesses interviewed had generally not worked closely with users in designing their stoves. Instead, most had found an "established" stove model that had been tested with users elsewhere, or that had achieved favourable results in laboratory emissions/efficiency tests. Their assessment of the market viability of the stoves tended to be based on these lab evaluations, in terms of the likely fuel savings to the user. One small Indian business had received support from the state government to provide end user subsidies for a stove model that had been developed and widely distributed during the first Indian National Cookstove Initiative (1984–2002). This entrepreneur reported that carbon revenues would be used to cover operational costs, including monitoring and management fees, and that the initiative would not be possible without the additional government finance. The value proposition offered to customers by the smaller businesses generally relates to the technical improvements that the cookstove can achieve, rather than how well the stove meets their particular needs. As noted above, the smaller businesses also plan to use carbon revenues to cover price subsidies (66–80%), on the grounds that their target customers could not afford the upfront cost.

The warehouse of a large improved-cookstove producer in Nairobi, Kenya.

Beyond piloting a couple of different stove models and assessing which the households preferred, the NGOs interviewed had not taken a particularly user-focused approach to the selection of a stove for their target households. A more in-depth market analysis was not considered necessary by the NGOs, since the households were not expected to purchase the stoves.

Monitoring, reporting and verifying stove use

As noted in the PDD review, carbon finance methodologies require projects to confirm that households are using their improved stoves, and at the predicted rates. A first step in this process of monitoring, reporting and verification (MRV) is to keep a registry of all stoves users included in the project, and their whereabouts. This registry serves as a basis for MRV activities, including surveys and sampling visits. Interviewees described different mechanisms for tracking stoves. An approach in Kenya used by several implementers was for users to register using their mobile phones, thereby reporting the whereabouts of their stoves. Other ways include registering the serial number of the stove at the time of purchase. In projects implemented by NGOs, where the stoves are distributed to a pre-defined number of households (as opposed to sold on a market), this type of electronic after-sales registration was not considered necessary. Instead, users were tracked through a village registry managed by project staff.

A majority of the project implementers interviewed for this study use consultants to monitor and verify stove use. These consultants are known as "validators". The most common verification method among our interviewees was for the validator to visit a sample of households. During these visits, the validator will generally check if the stove is in use and ask questions about usage rates. A limited number of the project implementers interviewed, and notably the NGOs, do their own monitoring. In their case, this involved hiring local monitoring staff from the villages where stoves were being used.

While MRV is a prerequisite for generating carbon credits, it is clear from our interviews that many project implementers experience benefits from MRV that go beyond generating carbon offsets. One NGO respondent noted that monitoring stove use allowed the project implementers to interact with end users on a regular basis, which in turn allowed them to identify and solve problems with the stoves, so they would work better for households. Another noted that a clear benefit of monitoring is that usage data becomes available in real time, and provides a good foundation for better understanding households' usage patterns and preferences. A third noted that the 10-year crediting period of a CDM project ensures longer-term monitoring, providing a good foundation for sustained long-term project implementation. For a majority of the implementers interviewed, the cost of monitoring

stove use is covered by carbon revenue, and would not have happened in the absence of carbon finance.

After-sales support and maintenance

After-sales support is seen as crucial to the long-term success of cookstove projects, as it builds credibility and legitimacy around the technology in users' minds. It is also a key factor in persuading consumers to take a risk and invest in a relatively unknown product, and thus plays a vital role in building a market for improved stoves. A large share of respondents (11 of 17) reported using carbon revenues to cover the cost of stove repair and maintenance. The larger businesses said they would provide after-sales service (e.g. a one-year warranty) because it is good business practice; two mentioned using carbon revenues for this purpose. Several private-sector respondents, particularly smaller businesses, noted that the monitoring required by carbon finance projects provides an opportunity to follow up with households, check that stoves are being used correctly, and deal with maintenance issues, which they might not have done otherwise. Both of the social enterprises interviewed reported using a portion of carbon revenues to cover after-sales maintenance of their products. Three out of five NGOs interviewed reported using carbon revenues for follow-up with households, since it was crucial to ensure that they continued to use the stoves. Two out of five NGOs mentioned that they were struggling with covering these costs, and had not factored them into their original project budgets.

5.3 Resource mobilization: Implementer and end user

As noted in Section 2, along with engaging end users, another key challenge for cookstove projects is securing adequate resources: both to develop and implement the projects, and to enable households to buy the stoves. This section examines the extent to which project implementers pursuing carbon revenues have access to additional resources (financial and technical), and the impact this has on their business model. We also look how projects deal with the challenge of accessing finance for end users, and what role carbon finance may play. Finally, we investigate the effect of financial incentives for stove buyers on the success of cookstove business models.

Access to finance for project implementers

Access to resources including finance, but also human resources (technical capacity, marketing expertise) is a key prerequisite for entrepreneurs seeking to enter the cookstove market (Simon et al. 2012; Atteridge et al. 2013). The costs of product development and testing, marketing, establishing rural distribution channels are significant, and it is often difficult for smaller players to leverage the resources necessary to penetrate the market. Not surprisingly, our data show that large and medium-sized companies are best placed to leverage the investment needed to get their business off the ground. All of these respondents had access to significant streams of finance (aside from carbon revenues): investments by global corporations, large commercial loans, a pool of angel investors, or personal investments. In most cases, this finance was in place early in the business development process, allowing for thorough market analysis and product R&D. One large actor reported that carbon revenues were an essential element in building up the business, as they were used to leverage other investment; the founders of the company had particular expertise in carbon finance, so it had been a relatively easy route to take. However, after only four years, the business model was no longer relying on carbon finance to be viable – it was sustainable on its own terms. Aside from this example, none of the larger actors pursued carbon revenues prior to securing initial seed capital/technical capacity to build the business – in each case, carbon finance came at a later stage, once the business model was deemed viable. Interestingly, one medium-sized entrepreneur who had registered a CDM project was no longer actively pursuing carbon finance, since the business model is viable on its own, and investors "tend to become concerned when carbon revenue is part of the business model", as it implies inherent risk in the enterprise.

Only one of the small businesses had access to additional finance, in the form of government support to cover high price subsidies to the end user. Without this support, it is unlikely that carbon revenues alone could ensure the viability of the business. Both of the social enterprises reported having access to seed capital early on to get their businesses off the ground. All of the NGOs interviewed were operating without any other source of finance, which placed them in a precarious position, given that they are not earning any revenue on stove distribution, and all the costs are being covered by carbon finance. They were relying on advance payment for carbon credits to cover upfront costs – a risky financial arrangement, as the collateral for the loan (carbon credits) is yet to be generated. Notably, the NGOs were under a lot of financial constraints, including difficulties to cover basic running costs, cookstove production or purchase, and staff. Sector experts both in Kenya and in India were of the opinion that carbon finance is generally not an appropriate funding source for NGOs, since they lack supplementary finance or "safety nets" that they

can rely on if there is a delay in implementation, or if there are external "shocks" such as a sudden drop in the global price of carbon.

Access to finance for end users

Interviewees described several innovative approaches to helping households access finance to buy stoves. A majority of the businesses were using microfinance institutions or village lending schemes to help customers access finance to buy the stoves. Village-level lending schemes, including "merry-go-round" schemes, are very common in Kenya, and several Kenyan-based private actors, particularly the larger ones, had established strong links with such organizations to finance and distribute their products. One of the large Kenyan-based distributors offers stoves at the wholesale price, an almost 50% discount, if a group of 10 or more customers place an order. The deal does not require paying right away – customers simply inform the distributor when they have saved up/accessed the finance and the stove is delivered. All of the large and medium-sized actors, particularly in Kenya, noted the importance of having an established rural distribution network to tap into village-level savings and loans facilities. This is similar to what we found in the PDD review, which showed that a majority of projects are relying on established networks to distribute their products.

A number of actors were linking up with microfinance institutions to offer a full "package" in terms of product, finance and after-sales support, with the MFI typically handling marketing of the stove. One large commercial operator in India reported that cooperating with MFIs had allowed it to reach lower-income rural households that had been previously inaccessible because they were geographically dispersed and lacked access to finance. The MFI played a crucial role in awareness-raising and stove marketing, often by demonstrating the stoves when customers come to its offices to access loans for other purposes. The MFI is also responsible for maintaining a database of sales necessary for carbon monitoring, and it provides after-sales support, replacing broken stoves. In terms of target market, it should be noted that although this customer base is low-income, the stove producer is not targeting the very poorest population.

With one exception, among the large- and medium-scale private sector actors interviewed, those that are using innovative finance mechanisms to help end users buy stoves do not rely on carbon finance for end user subsidies. Conversely, none of the smaller businesses or NGOs interviewed reported use of such mechanisms, and all were relying on carbon finance to reduce the cost of the stove to the end user. The two social enterprises interviewed are working closely with microfinance institutions to facilitate end user finance as well as rural distribution and delivery of their products.

Use of subsidies

Although the PDD review indicated a high proportion of registered projects planning to use carbon revenues for direct subsidies, it should be noted that only 10 out of the 75 registered carbon-financed cookstove projects in India and Kenya have issued carbon credits. These include nine Gold Standard projects and one VCS project that is also registered as a PoA under the CDM, but has not yet earned CERs. This makes it difficult to analyse the actual impact that high-end user subsidies might have on market development. For the purposes of addressing our research questions, we rely instead on data from interviews conducted with entrepreneurs *not* planning to pursue carbon finance and household energy sector experts in India and Kenya, as well as the literature on the use of subsidies for cookstoves.

The stove entrepreneurs we interviewed who are not pursuing carbon finance were generally critical of the use of large price subsidies to end users. In India, three large stove businesses shared the view that providing free or highly subsidized stoves will not be sustainable in the long term, because they will not be valued by the users. These actors stressed that this was the reason for the failure of the first Indian National Programme on Improved Cookstoves, and expressed concerns that the current National Programme is in danger of following the same path by supporting direct subsidies for stoves. Neither actor felt that their own business had been negatively impacted by other players having accessed carbon revenues, but both noted that it was probably too early to make such an assessment, given that so few stove projects have generated carbon revenues. These views were generally shared by the sector experts interviewed in India, who stressed that for carbon revenues to support market transformation across the sector, the business model must be "solid" from the beginning, and that high-end direct subsidies undermine the longer-term sustainability of the business.

In Kenya, we interviewed three small-medium enterprises not currently pursuing carbon finance. All were of the opinion that it is critical to have a viable business in place before pursuing carbon revenues. One interviewee was considering carbon finance as a future option, to support stove sales in poorer communities, but only once the core business was sustainable.

Financial incentive for end users to purchase stoves

Where households are purchasing fuels, there is a clear financial incentive to switch to an efficient cookstove (Barnes et al. 1993; Bailis et al. 2009; Brinkmann et al. 2014). As reflected in the review of PDDs, most of the actors interviewed are distributing improved wood-burning stoves. Many of the households we interviewed mentioned that improved stoves would save time gathering fuelwood and would cook faster, but since fuelwood is mostly gathered free of charge in rural Kenya and India, there is no direct financial incentive for a household to switch stoves.

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A stove-maker for Wisdom Stoves, a U.S.-based nonprofit, works in a shop in North Kinangop, Kenya.

Two of our interviewees were marketing stoves to households that now purchase cooking fuels. One, a small business in India, is using carbon revenues to distribute an advanced pellet gasifier cookstove to households that now buy fuelwood. The households will purchase pelletized fuel, which costs 1-2 rupees (about $0.02-0.03 USD) less per meal cooked than fuelwood. The interviewee was certain that the cheaper fuel, plus a significant subsidy (two-thirds of the stove's retail price) will guarantee that households will adopt the stoves. In Kenya, meanwhile, a large-scale actor is producing improved charcoal Jikos capable of achieving 50% savings on charcoal, and has demonstrated a large potential market in urban and peri-urban areas, where the majority of households buy charcoal for cooking. This actor reported that unsubsidized sales to lower-income households were increasing, since these households frequently spend upwards of 300 KSH ($3.50) per week on charcoal, and the price of charcoal is rising.

5.4 Supporting competition, innovation and scalability of cookstove initiatives

Several interviewees in Kenya – including some who are not seeking carbon credits – reported that carbon finance has improved the way in which cookstove businesses are run, since revenues are only available once strict monitoring has been conducted to demonstrate that the stoves are actually being used. One large enterprise pursuing carbon revenues said the crash in the global price of carbon has actually strengthened the project's core business model: Unable to rely on carbon revenues to cover price subsidies, the project had ended the subsidies and focused instead on ensuring that the product meets users' needs, strengthening rural distribution networks, and engaging with innovative financing mechanisms.

Most of the cookstove entrepreneurs that we interviewed are of the opinion that competition between various cookstove producers is having a generally positive impact on the market, and that "market leaders" can pave the way for new actors to enter.

A number of Indian stove producers and distributors not pursuing carbon revenues expressed concerns about the dominance of a large stove producer that is receiving financial support from a multinational company, which allows it to subsidize the price of the stoves to the end user. Several producers reported having difficulties competing with this company, and said the subsidy is having a distorting effect on the market.

Most cookstove producers in Kenya report that the presence of carbon finance has had a generally

positive impact on the market in terms of "levelling the playing field" and allowing smaller actors to enter. For example, several of the medium to large producers have now added carbon consulting services to their business models, whereby they cover all of the upfront costs of project registration in exchange for 30% of the eventual carbon credits accrued. Several small- and medium-scale producers in Kenya reported that this approach to registering a carbon project was less costly to smaller enterprises than engaging a larger carbon consultancy.

A number of medium- to large-scale stove producers in Kenya said the market was now "ripe" for their businesses to establish themselves, and that carbon revenues had been a key contributing factor in this, in a number of ways. Crucially, these actors reported that carbon finance had allowed several large international players to enter the scene, which had opened up the market for higher-quality stoves that had not previously been available.

© BURN Manufacturing

BURN Manufacturing produces and distributes the Jikoka natural-draft charcoal stove in Kenya. Since July 2013, stoves are assembled in Nairobi and in July 2014, BURN will open a production facility that manufactures complete stoves.

6 WHAT ARE THE BENEFITS AND RISKS OF USING CARBON FINANCE FOR STOVE PROJECTS?

Drawing upon the insights from our research in Kenya and India, this section provides a more in-depth discussion on the benefits and risks associated with using carbon finance in cookstove projects. As we noted in Section 2, the scope of our study is too narrow to generalize our findings beyond the Kenyan and Indian contexts; however, we do want to highlight several issues that warrant further exploration.

6.1 Benefits of using carbon finance for implementing improved cookstove interventions

The findings of our study suggest that the use of carbon finance can benefit – and sometimes even strengthen – the business model for improved cookstove interventions, in two key ways. First, the extra money from carbon revenues can strengthen the business on multiple levels, including leveraging external funds and providing finance options for end users; this can be particularly valuable if projects can team up with local microfinance institutions. A second key benefit is that the monitoring and reporting requirements of carbon finance encourage greater follow-up by the projects, which helps them ensure long-term uptake of the stoves, monitor performance, and draw lessons to improve the business models.

Several medium- to large-scale actors in Kenya described how carbon revenues allowed them to engage with microfinance facilities by providing guarantees on loans to cover the upfront cost of stoves to end users. This engagement has allowed cookstove enterprises to connect with distribution channels used by microfinance institutions, providing access to dispersed rural markets. A number of actors, both in India and in Kenya, are also leveraging carbon revenues to access other streams of investment. One large actor in Kenya said that the ability to leverage private investment against carbon revenues in the startup phase had allowed the company to grow rapidly, so by the time carbon prices dropped, the core business model was strong enough to withstand the crash and continue without relying on carbon revenues.

Our findings also suggest that carbon finance can provide a boost to the development of markets for improved cookstoves. This was particularly true in Kenya, where many interviewees said market penetration and uptake had really increased since 2008, when carbon project development took off. A study commissioned by the U.S. Agency for International Development (USAID) supports this view; it notes that donors and NGOs have largely driven the development of the improved cookstove sector in Kenya, and the introduction of carbon finance has attracted larger international players (Winrock International 2011). The diversification of market actors has also led to more imported and mass-manufactured stoves being made available on the market (ibid).

The monitoring and reporting requirements of carbon-financed projects may be improving the market as well. Keeping a registry of stove users provides implementers and technology developers with the necessary infrastructure to collect information on actual uptake of stoves – an aspect that has often been missing from conventionally implemented cookstove interventions. Importantly, the prospect of additional carbon revenues also created the financial incentive to monitor continued use over time in order to generate additional carbon credits. Furthermore, the reporting and monitoring requirements have forced some implementers, in particular NGOs, to be more efficient, transparent and thorough in project implementation, including paying increasing attention to accountability and measurable results.

Another benefit that stands out is the prospect of being able to sustain implementation over a longer time period. This option was particularly referred to by NGOs, social enterprises and smaller businesses operating under financial constraints. Extending operations helps ensure that the health, development and environmental benefits associated with cookstove interventions are not lost after the project ends.

Finally, several interviewees mentioned that the follow-up required for carbon-financed projects would help them document additional development benefits associated with improved cookstoves, to get an indication of how livelihoods are improving as the projects are implemented. While most also noted that it is difficult to accurately quantify and measure additional development benefits, one carbon consultant said the process of monitoring and reporting allows for collecting "anecdotal" evidence of additional developmental benefits – for instance through video documentation – which is often enough to meet the

buyers' demand. This was noted as particularly important for corporations purchasing credits for CSR purposes.

6.2 Risks and uncertainties associated with carbon finance

Cookstove projects face many inherent challenges: from understanding and meeting users' needs, to securing the financial, technical and human resources needed for successful implementation. As discussed above, carbon finance can help projects meet some of those challenges – but it can also place additional demands on implementers, and introduce new risks, barriers and uncertainties. In this section, we discuss both how the "carbon element" interacts with risks inherent in cookstove projects, and the new risks that carbon finance can bring.

Risk 1: What works best for cookstove projects may not be best for generating offsets

Carbon offset projects are meant to reduce greenhouse gas emissions as cost-efficiently as possible. Several of our interviewees suggested that there was a mismatch between the efficiency needs of a carbon project and the complexities and cultural sensitivities required for a successful cookstove intervention. Sector experts and project implementers with experience developing and introducing new technologies to households noted that carbon finance assumes both a stove design and a usage rate that minimize emissions. However, in practice, there is seldom a perfect fit with users' behaviour and preferences, which are deeply rooted in societal and cultural contexts and not steered by principles of efficiency (Bielecki and Wingenbach 2014; Hanna et al. 2012). Previous research has also pointed to certain imperatives of carbon projects that may not fit well with the needs of projects targeting a heterogeneous consumer base. These include the need for a high volume of stoves to lower transaction costs and generate a sufficient number of credits; technological performance standards that limit the types of stoves that may be used; and the need for standardized emission inventories and calculations to be able to reliably calculate actual achieved reductions (Simon et al. 2012).

© SEI / Fiona Lambe

A traditional stove, left, and an improved biomass cookstove in Kenya.

Risk 2: Uncertainty around stove uptake and usage rates

One of the biggest risks in carbon-financed cookstove interventions is that the number of credits generated is contingent on the individual end users' uptake of the improved stove. While a reliance on individuals to implement a carbon project is not unique to improved cookstove interventions, the large scale needed to make projects financially viable adds to the difficulties in predicting carbon revenues.

Our research suggests that project designers struggle to make reliable uptake predictions at both the individual household and aggregate levels. One interviewee with experience in project design and verification said it is not uncommon for the baseline assumptions to underestimate fuel usage with traditional

stoves by as much as 40%. This, in turn, can skew the projections for fuel usage with the new stoves, and can result in projects generating a smaller volume of credits – and revenue – than predicted. This is a particular concern for implementers who are solely relying on carbon revenues.

Project designers also appear to overestimate the incentive created by fuel savings from using the improved cookstove, especially when the fuel is being collected free of charge. Our PDD review found most projects assume that cooking fuels are free, but our interviews and the literature suggest that the incentive to switch is stronger when end users are purchasing fuel (Ruiz-Mercado et al. 2011). While freely available fuelwood should not be seen as risk to project implementation, it appears to constitute a potential barrier to implementation that project designers need to be aware of.

A further complication relates to the issue of stove "stacking". As previous research by SEI and others has shown, households often use different stoves and fuels for different purposes, such as to optimize flavour or control cooking temperatures (Lambe and Atteridge 2012; Ruiz-Mercado et al. 2011). As discussed in the review of PDDs, designers of carbon projects sometimes try to avoid this risk by demanding that traditional stoves be dismantled. Just under 10% of the projects reviewed require traditional stoves to be destroyed, and use this as a basis for assuming a 100% switch. Many experts criticized this approach; one called it "using the wrong means to achieve the wrong end".

Risk 3: Project developers may underestimate the time and effort required to generate carbon credits

In addition to the uncertainties around stove uptake, projects face challenges in monitoring usage of the stoves. Findings from our interviews suggest that monitoring of carbon-financed cookstove projects is often done through cluster sample interviews, which involves visiting a select number of households in a defined area. While this is an accepted way of monitoring, several interviewees knowledgeable about monitoring methods said this is neither a reliable method nor an entirely representative way to sample user uptake.

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Four stoves in a single household in Rajasthan, India – clockwise from top left: improved cookstove; traditional clay chulha; metal stove that collects ash for fertilizer; traditional clay chulha made with a mould.

More generally, our research suggests that project implementers with little or no prior experience with offset projects may not always fully understand the time and effort needed to generate carbon credits. Several of the carbon consultants interviewed said that many times they have had to manage clients' expectations as to how soon carbon credits will be generated. Many project implementers also said they had (grossly) underestimated the costs and complexities involved in monitoring actual use of their stoves, including unforeseen behaviour patterns such as end-users using different stoves for different cooking purposes. According to one carbon finance specialist, the realization of how complex the implementation process is can often lead

implementers to either discontinue their stove projects or minimize the scope: "Improved cookstove projects are seldom as long-lived as the project cycle allows, nor do they disseminate as many stoves as originally planned – often more like 40-50%."

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An LPG stove, above, and a traditional chulha, below, in a single household in India.

Risk 4: Changing national policy environment

An additional uncertainty mentioned by a few cookstove project implementers in India (both using and not using carbon finance) was the national government's subsidy on LPG. The subsidy goes directly to consumers; households currently pay about 50% of the current market price per cylinder of LPG (see Lambe and Atteridge 2012 for further discussion). As LPG penetrates further into rural areas, it is becoming the new benchmark for clean cooking, attaching a stronger aspirational value to LPG burners than to improved biomass cookstoves. Furthermore, because LPG burns without any smoke, the health benefits of switching to an LPG burner are much greater than for an improved biomass stove (Ochieng et al. 2013; Mehta and Shahpar 2004). Thus, the LPG subsidy is effectively competing with the National Biomass Cookstoves Initiative, and with the individual projects promoting biomass stoves. The subsidy poses a challenge to all biomass cookstove projects, but may be of particular concern to carbon-financed projects, as any (reported) usage of LPG means a reduction in the number of credits generated.

Risk 5: Uncertainty about future demand for carbon offsets

The single biggest threat to the implementation of carbon projects – not just those distributing cookstoves – is that the demand for carbon credits is currently minimal. This is particularly risky for projects that rely on carbon finance as their only source of funding. Currently, demand for CERs is closely pegged on economic performance and political decisions within the European Union, by far the biggest carbon market in the world. However, the EU ETS seems both politically unable and unwilling to absorb a high supply of credits; this is evidenced, for example, by a quantitative limit on the use of international credits in the third trading period (2013-2020) of the EU ETS.[21] The EU decision to backload 900 million credits for trading in the third phase has helped, but only to a limited extent. While other carbon markets exist (for instance, in California and New Zealand) and are emerging (for instance, in China and South Korea), there is no indication yet that those markets will make a real impact on demand for CERs, if they are even eligible for compliance.

In the voluntary market, meanwhile, while our study shows that there is continued interest from buyers – notably large corporations buying for CSR purposes – in cookstove and other small-scale projects, corporate demand is often cyclical and sensitive to trends in CSR investments. While interest in climate change mitigation is still quite strong, it could shift, sooner or later, climate adaptation, water management, disaster risk reduction, etc. While corporations are increasingly becoming development actors, the extent of their involvement ultimately depends on financial conditions.

21 See http://ec.europa.eu/clima/policies/ets/linking/docs/c_2013_7261_en.pdf.

7 IS THERE A FUTURE FOR CARBON-FINANCED COOKSTOVE INTERVENTIONS?

As mentioned at the outset, the limited scope of this study – focused on India and Kenya – does not allow for broad generalizations based on our findings. However, in this section, we present some general observations based on the evidence collected, and end by suggesting areas for further research.

7.1 Do improved cookstove projects deliver high-quality carbon offsets?

The focus of our study was to investigate the role of carbon revenues in developing markets for improved cookstoves. However, it is also important to ensure the environmental integrity of carbon-financed cookstove projects – that the credited emission reductions are real, additional, quantifiable, verifiable and permanent. This means, among other things, that the emission reductions would not have happened in the absence of support from carbon finance. Projects must also properly account for leakage and uncertainty, and apply a realistic baseline. Improved cookstove projects, like other offset projects, rely on project-level accounting requirements to establish what emission reductions are eligible and how they are quantified to meet the quality assurance criteria for a specific offset program.

Improved cookstove projects need to be able to demonstrate that they offer credible and scientifically robust methodologies for estimating, monitoring, and verifying emissions reductions. In prior work, we have reviewed existing carbon market methodologies for improved cookstove projects, including those from the CDM and the Gold Standard (Lee et al. 2013). This analysis found that there is considerable room for improvement in how climate benefits from improved cookstove projects are estimated and accounted for. We recommended, for example, requiring accounting of uncertainty, reviewing the integrity of default factors for the fraction of biomass used that is non-renewable, and evaluating the use of fossil fuel CO_2 emission factors as surrogates for biomass combustion.

Our interviews with market actors suggest that the business models of many projects do not require carbon revenues to be successful, and there may even be advantages in not depending on carbon revenues. Although this does not jeopardize the eligibility of these projects under the applicable carbon offset methodologies, it does raise significant concerns about the environmental integrity of emission reductions achieved from improved cookstove projects. We recommend further investigation to address the implications of this issue.

7.2 Is carbon finance suitable for improved cookstove interventions that aim to achieve a market transformation?

Not all cookstove interventions aim to achieve a market transformation. As part of this study, we spoke to several project implementers whose primary motivation was to generate profits. That said, many cookstove project implementers are in one way or another "development professionals" who aim to improve living conditions for end users. To them, it becomes particularly important to understand what a sustainable business model for improved cookstoves entails, and whether carbon finance is compatible with this or not.

Based on insights extracted from interviews with cookstove producers and distributors in India and Kenya, the following key elements appear essential for sustainable cookstove business models. Points 1 to 4 are true for any cookstove project, regardless of whether pursuing carbon revenues or not:

1. Technology is developed in close collaboration with end users, including field testing with several design iterations.

2. The project has access to supplementary funding sources to absorb upfront costs and implementation costs for the first year(s).

3. There is follow-up with users, including technical support, monitoring and repairs.

4. End user finance is included in the "package", e.g. by working with a microfinance institution.

5. Project implementers have a thorough understanding of the complexities and costs involved in a carbon project, including costs for monitoring, the time it takes to generate credits, etc.

6. The project design reflects a realistic understanding of stove stacking and multi-stove use. In most cases, this means it should not assume a 100% switch; other stoves will be used.

Our findings show that carbon finance can be valuable to support further dissemination of improved cookstoves. It can help build an increasingly vital market for improved cookstoves, attract international actors and technologies, help establish standards for monitoring stoves, and facilitate better follow-up and support to end users. Although our research underscores what the literature says about the potential for high-end direct subsidies on stoves to devalue the product in the eyes of the user, and thus damage the wider market for improved cookstoves, a systematic assessment of the impact of carbon-financed price subsidies was not possible, given that most projects in Kenya and India are in early stages.

Our study suggests that there is nothing inherently damaging in using carbon finance in cookstove interventions. In fact, carbon finance can – but does not necessarily – help overcome the key obstacles to achieving market transformation: lack of end-user motivation to switch, and lack of resources. Our research also shows that carbon finance can help projects get off the ground and incentivize a follow-up process to better understand whether the new technology is adopted by the user.

As discussed in Section 6.2, maximizing emission reductions would require that 100% of households adopt their new stoves and use them for all their cooking, and this is usually unrealistic. However, stove uptake and usage rates can be maximized if ample attention is paid to understanding users' preferences when the technology is developed and introduced. The key issue is whether the implementer has chosen a stove that users are likely to accept, and made it affordable by providing finance options for households. The project also needs to have sufficient funds to develop an intervention that can be sustained over time. The question of appropriateness thus seems to be one that goes beyond carbon; our findings suggest that the elements that maximize emission reductions are the same ones that lead to success in all cookstove projects.

7.3 Is it worth the extra effort?

Our research has shown that cookstove projects use carbon finance in a wide array of different ways. Thus, there is no simple answer to the question of whether the pursuing carbon finance will pay off. Applying a carbon finance component to an improved cookstove intervention involves extra costs associated with project registration, monitoring and follow-up. Access to technical expertise is also required to register a project. For some implementers, these requirements imply relatively substantial alterations to the planned business model, such as securing enough funds to cover the upfront costs, monitoring and follow-up. To other implementers, the additional requirements fit relatively well with the already planned business model, and involve "only" the inclusion of a tracking device, or splitting the revenue for the sales of carbon credits with a carbon consultant.

That said, along with bringing in revenues, the process of engaging with carbon finance can provide crucial capacity-building for the cookstove sector in terms of accessing results-based finance. For example, our study showed that many projects seeking carbon finance are adopting strict measures for monitoring and evaluating their progress. This may mean that cookstove actors will be well placed in the future to benefit from other results-based finance mechanisms, even in the absence of a demand for carbon credits. This is a key point to bear in mind as we get a better understanding of the appropriateness of this approach to the sector.

Are there times when carbon finance for cookstove projects makes (more) sense?

Unless the implementer has access to a "safety net" in the form of supplementary funds, the risks involved in using carbon finance for improved cookstove interventions are notable. Thus, carbon finance may be more appropriate for business models that are sustainable regardless of prospective carbon revenues. Carbon finance can then be applied as an add-on to the existing business model, and the risks of "doing carbon" can be kept to a minimum. With the building blocks of a sustainable business model in place, our research demonstrates that carbon revenues can be particularly useful early on in the business development cycle, as a source of enterprise funding that can be used to leverage additional streams of revenue, or to provide end user subsidies to stimulate demand early on. There would thus appear to be a strong argument for "transitional" crediting, whereby carbon finance is designed to phase out relatively quickly where market transformation can be stimulated. However, as noted in Section 7.1, carbon finance is intended to support activities that would not have happened without the offset revenue, so the emission reductions are truly additional. Thus, applying carbon finance when the existing business model is sustainable on its own could challenge these additionality criteria.

Conversely, our study, while limited in scope, suggests that relying solely on carbon revenues to fund project implementation may be overly risky. As discussed in Section 6.2, there are also inherent risks and uncertainties in seeking carbon finance. Therefore, the prospect of carbon revenues should not lead project developers to take financial risks that they would otherwise have avoided.

Will there be a market for cookstove projects' offsets?

Future developments in the international carbon markets are uncertain. Prospective demand for carbon credits hinges not only on the ambition level of governments and corporations when it comes to climate mitigation, but also on their willingness to use carbon credits to achieve these targets. If cookstove project implementers are to make the effort to pursue carbon finance, they need to ensure that there is a market for the credits they produce.

Our research and the literature suggest that corporate demand for credits is inherently uncertain and difficult to predict in the long term, so national governments will play a vital role in creating long-term demand. This requires setting more ambitious mitigation targets – nationally and internationally – and allowing international carbon credits to be used to meet those goals.

Areas for further study

There is a clear need to better understand the advantages of introducing a new cookstove "the carbon way". In particular, further work is needed to understand whether a programme of monitoring, maintenance and repairs, which is often stipulated in carbon finance interventions, will actually increase end-user uptake of the new technology. The best way to determine this would be to compare an intervention using carbon finance that has monitored use for a longer time period with a "control group" of interventions that do not do monitoring and follow-up. This would also shed light on the broader impact of carbon finance on improved cookstove project implementation. An analysis of this kind would be particularly interesting in India and Kenya, two markets that have had improved cookstoves long before carbon finance.

As the projects covered by this study are in early stages, we could not assess the actual impact of carbon finance on market transformation – only how it has affected business models. We see real merit in re-evaluating the projects when implementation is further along. Additional country studies are also crucial, to examine how carbon finance may be affecting market transformation in other contexts. This would allow us to distil some generalizable conclusions regarding the appropriateness of carbon revenues for different cookstove actors/business models. Such an analysis could also include a consolidated analysis on the interlinkages between the motivation of the project developer/implementer, the business model used (including choice of stove), the national policy environment, and the use of carbon. Finally, we would recommend further research to explore the possibility of short-term, transitional crediting for cookstove projects, and how carbon revenues can best be targeted to stimulate market development, then phase out over time.

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ANNEX 1: LIST OF INTERVIEWEES

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Dr Karabi Dutta, Sector Expert

Dr. Priyadarshini Karve, Sector Expert.

Ravi Kumar P, Envirofit India Private, Ltd.

Harish Anchan, Envirofit India Private, Ltd.

Gopal Kabra, Energy Marketers

Jon Salle, Prakti Design

Moushine Serra, Prakti Design

Mahesh Yagnaraman, First Energy

Neha Juneja, Geenway Grameen Infra

Paul Zhang, Vitol

T. Pradeep, SAMUHA

Rajiv Dandekar, Ram Tara Engineering Company

Ronak Shah, Seva Mandir

Sandeep Kanda, South Pole Carbon

Sujatha Srinivasan, Servals

Households in Kerawa (2)

Households in Solapura/Rampura (4)

James Dailey, Micro Energy Credits

Alice Rouault-Reillon, Livelihoods Network

Havard Norstebo, Green Development

Job Orina, MyClimate

Lucas Blenkly and Björn Hammar, Top Third Ventures

Nele Groosman, Paradigm Project

Peter Scott, Burn Manufacturing Corporation

Households using Wisdom stove (3)

Amanda West, Ecozoom

Daniel Waithaka and Nathan Puffer, Wisdom Stoves

Nathan Gachugi, Viability Africa

Households in Salga (3)

Tom Morton, Climate Care

Peter Malomba, Improved Stoves Association Kenya

Anna Ingwe, GIZ Kenya

Laura Clough, GVEP

Michael Kyenze, Catholic Diocese of Kituyi

Lloyd Archer, CO2 Balance

Alice Thuita, Help Self Help Center, Narumoro Town, Nyeri County

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